Rendered Quality Water White Coconut Oil

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ABSTRACT AND SUMMARY

Practically water white coconut oil prepared by either a physicomechanical (PM) or an improved rural process (RP) is highly stable. It has low (0.03%) free fatty acid content and needs no further purification to attain edible quality, especially when the fresh coconut flavor so desirable in confectioneries is relished. PM oil has better stability than RP because the former contains more of the major phospholipid. The RP oil reported herein is a marked improvement over a related product which American chemists in the Bureau of Science, Manila, found in local use as early as the start of the 20th century.

INTRODUCTION

Before the Americans and Europeans brought their technology to produce inedible copra oil and the technology of purifying copra oil to edible coconut oil, which costs more than twice as much as copra oil in international trade, the Filipinos prepared coconut oil for culinary purposes by rendering coconut milk pressed from comminuted meat of matured coconuts. The American chemists in the Bureau of Science characterized this oil as dark brown with burnt odor and taste; it easily rancidified which forced the production of small amounts to last for only a few days. Also copra oil produced was often rancid. Hence, the Bureau chemists began to study the problems of rancidity (1) of coconut oil in the first decades of this century. The better quality Cochin type coconut oil was given a premium price over poor quality Philippine copra oil. This prompted Parker and Brill (2) of the Bureau of Science to attempt the production of better dried meat and while it was still warm to press it with a mechanical press without generating high temperature while in operation. They reported water white oil free from acidity and rancidity with an efficiency of 80% extraction. They attempted wet processing and produced two classes of oil from solidified cream, one with fermented characteristics from a portion of the solid cream which was left aside to ferment, and another a water white oil free from acidity and rancidity by just heating gently the rest of the solid cream to form an oil layer on top.

Over three decades later the first Philippine patent (3) was granted to two sugar chemists for a process that produces coconut oil with fermented characteristics. It was tried in a pilot plant. A bigger plant was built complete with a battery of centrifuges, deodorizer, screw press, steam boiler, refrigerating outfit and accessories based on a process similar to that of Parker and Brill involving solidifying of coconut cream and then heating to liquify the solid cream. The battery of centrifuges seperated water white oil from the liquified cream. The factory operated for a time producing one ton of edible coconut oil a day.

The physicomechanical (PM) process (4) was given a U.S. patent in 1963 but was developed much earlier during the last world war when the developer was out of the government service. A team of researchers of NIST studied the stability (5) of edible coconut oils in the Manila market including PM coconut oil. They reported that the dry processed edible coconut oil had better stability and that the high quality water white PM oil gave the longest induction period. This strengthened the view that the oil of the biggest nut has an effective natural antioxidant present in it to display exceptional stability maintaining coconut oil freshness for years.

It was mentioned earlier that the rendered locally prepared coconut oil for culinary purposes rancidifies shortly. It is dark brown and has a burnt odor and taste. A critical study (6) of the variability of saponification values of differently processed coconut oil indicated that heat applied in the process is a principal factor in the loss of the major phospholipid of the oil to produce variability of saponification value (SV) of coconut oils which were differently processed. This study was extended to other natural fats and oils and found to have wide coverage (7). It was of great interest to prepare coconut oil by rendering coconut cream by controlling heat to avoid both yellowing of the oil and browning resulting in great loss of major phospholipid which has been shown to cause variability of SV and variable stability (8) of differently processed coconut oils.

TECHNICAL DETAILS OF RURAL AND PHYSICO-MECHANICAL PROCESSING AND PRODUCT PROPERTIES

Improved Rural Process

Only matured coconuts with dark shells are used in the improved rural process; they are dehusked at the coconut farm. The remaining portion of husk, coir dust, and fibers are removed from the nuts, which are then washed and dried before they are used. The clean nuts are halved, and the coconut water is saved for a second pressing of milk. The halved nuts are comminuted in the half shell, and comminution is stopped before reaching the brown testa. The testa with a thin portion of meat is dislodged from the shell by a blunt knife to be dried and stored. When enough is collected, the dried paring is pressed like copra to yield paring oil which is yellowish and has a lower SV but higher iodine value than copra oil; it produces harder and whiter soap than copra oil.

A series of photomicrographs taken by Manzanilla (9) a few years back reveal numerous cylindrical cells arranged perpendicularly toward the cavity surface of the kernel filled by coconut water at a certain period in the development of the nut. Cells along the testa are short, but farther away they are longer and are supported by the cellulose fibers, for the kernel is firmly solid. These cylindrical cells must have membranes built up by phospholipids, proteins, and lipids. The cells contain cytoplasm, and the kernel is made up of 48% moisture, 35% oil, 4.3% proteins, 9.3% carbohydrates, 1.1% minerals and 2.1% crude fiber. Most of the water, oil globules, colloidal proteins, a great portion of the soluble proteins, carbohydrates, and salts are stored inside the cells as reserve food for the embryo. The cytoplasmic contents of the numerous cells make the natural milk of the biggest nut. One has only to press the comminuted white meat of a matured nut to obtain the coconut milk which is opaque like dairy milk and belongs to the same natural emulsions system of oil-in-water. The oil globules of coconut milk are surrounded or enclosed in a membrane (10) made up of phospholipid cephalin as emulsifier and salt and unknown proteins as stabilizers, while the fat globules of dairy milk are enclosed in a membrane (11) composed of phospholipid lecithin as

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TABLE I

Characteristics of Improved Rural Process (RP) and Physicomechanical (PM) Process Coconut Oils[a]

	RP	PM
Color	Practically water white[b]	Practically water white
Odor	Fresh coconut	Fresh coconut
FFA[c]	0.03%	0.03%
MP (initial)	25 C	-
SV	253.9	254.6
SV (bland oil)[d]	248.1	248.1
Mg KOH equivalent of cephalin content	5.8	6.5
Initial PV	0.0	0.0
Hours AOM conditions	40.0	42.0
Final PV	0.49	0.25

[a]Abbreviations: FFA = free fatty acid, MP = melting point, SV = saponification value, PV = peroxide value, AOM = active oxygen method.

[b]Lovidonb 0.5 yellow, 0.3 red.

[c]Calculated as oleic acid.

[d]To produce bland oils which carry no natural odor, hydration is continued until the last two consecutive SV values of the oil being hydrated are very close differing only two or three integers in the second number beyond the decimal point.

TABLE II

Saponification Values of Coconut Oil

Coconut oil with yellow color (Rendered from cream up to 130 C)	251.3
Carver pressed laboratory dessicated coconut meat oil	251.0
Coconut oil with mild fork odor (Hydration of cream to reduce proteins and other components)	249.9
Copra oil of commerce	249.9

emulsifier and stabilizer proteins.

To prepare coconut milk from the comminuted kernel, one has only to wrap two handfuls with cheesecloth and press it as in squeezing water from a wet cloth, or a mechanical press can be used. The liquid obtained in the first pressing appears thick, as it contains over 40% oil and over 6% proteins and may probably be called coconut cream. When coconut water or an equal volume of tap water is added to the solid residue called sapal and it is pressed, a thinner opaque liquid is obtained containing 17% oil that can properly be called coconut milk. Since no new cells are opened, the residual cytoplasmic materials left after the first pressing are washed off in the second pressing. The solid residue is still called sapal which on the dry basis contains from 18-20% oil.

When the coconut cream of the first pressing and the coconut milk of the second pressing are mixed together, what may properly be called coconut whole milk is obtained. It is freed from suspended particles after which it is centrifuged or allowed to stand to separate cream and the coconut skim milk. After 1 hr gravity separation, only 1% oil and 1.6 proteins are present in the skim milk. Holding for 2 or 3 hr increases the oil in the cream very little. The cream contains ca. 37% oil, 6% proteins, and 48-50% moisture. The coconut cream thus prepared is the material for the rural process (RP) and the physicomechanical process.

Most of the moisture of the materia prima, coconut cream, can be evaporated at 105 C till a jelly state is reached which needs higher temperature to lose its moisture and to destabilize the oil globules to release their oil. Heating at 120 C with continuous stirring to prevent overheating of proteins (causing them to react with reducing sugar to form the color produced by the Maillard reaction) is sufficient to inactivate the emulsifier stabilizer system of the numerous oil globules releasing their contents to form the so-called rural processed coconut oil. When the protein particles turn grayish, heating is stopped but stirring is continued until the temperature goes down below 100 C. The mixture is filtered while still hot, which allows the protein particles to drain off oil. The rendered rural oil is water white with fresh coconut flavor and low free fatty acid (FFA) of 0.03% as oleic and no peroxide value to start with. Table I shows pertinent characteristics of this improved rural process coconut oil. Table II compares SVs of differently processed coconut oils.

Physicomechanical Process (PM)

PM high quality water white coconut oil is prepared by a physicomechanical process mentioned in the Introduction. The process operates in the same manner as the one in which butter oil is prepared from dairy butter which is produced by churning dairy cream. In temperate countries where the dairy cow is highly developed, the dairy cream has natural churnable property as the butter fat globules are always solid. Coconut cream is not churnable, for the coconut oil globules are always in the liquid state in the tropics where the palms grow. By the PM process, the coconut cream is conditioned to acquire the property of churnability and only then can one produce coconut butter in the same manner as that in which dairy butter is prepared. Cooling coconut cream down to 5 C converts the liquid oil globules into firm solid fat; it can then be churned to produce coconut butter. At the beginning of the churning the coconut cream may still be fluid, and as churning continues it becomes thicker and attains a state of pastiness, sticking to the wall of the churning vessel. Further churning makes the mass lose its pastiness and begin to slip the surface of the container. Absorbing heat from surrounding fluid, the churned cream continually rises in temperature. When it begins to slip, it may have attained a temperature of 22 C. Further churning collapses the network of clumped solid oil globules enclosing the menstrum and thus the cream skim milk, which corresponds to buttermilk produced in dairy butter making, oozes out. It is allowed to drain into a container. By kneading the coconut butter, the moisture can be reduced to a minimal amount of 8%. When it is gently heated just to melting, the oil collects on top. PM oil prepared the same day the coconut cream is pressed gives the lowest recorded FFA of 0.01%. When the coconut cream is held overnight to produce the oil next day, even when it is kept in a refrigerator, the recorded FFA is 0.03% as oleic acid. Its SV is 254.6. The pertinent properties of PM high quality coconut oil are included in Table I.

DISCUSSION

Table I shows the character of rural processed quality coconut oil from rendered coconut cream separated from whole coconut milk. It has the highest saponification value of all the oils prepared by destabilizing the coconut emulsion with the agency of heat. The resulting dehydration causes the emulsifier-stabilizer system to lose its function entirely. This oil has the highest major phospholipid content, which has been shown by a reported work (6) to cause the variability of saponification values of differently processed coconut oils and also of other natural oils and fats (7). RP oil is practically water white, but if the temperature of rendering the cream is raised to 130 C, the prepared oil carries yellow color, and on further heating the brown color becomes darker as temperature rises. It appears that the major phospholipid cephalin decreases as the temperature of rendering increases. There are three possible pathways by which cephalin may be lost from the oil in which it is soluble; it may complex with salts in rendering the cream. It may react with the proteins and amino acids by its orthophosphoric moiety which has an acid reaction; its ethanolamine moiety may react with acid moieties of proteins or form condensation product with reducing sugars as in the Maillard reaction (12). In destabilization of coconut cream performed by Dendy (13) with acetic acid at pH 4 and by V. Lava (14) with hydrochloric acid at pH 3 to pH 5.6, it appears that it is the ethanolamine moiety of the phospholipid that is involved. Either acid forms its corresponding salt which appears soluble in the oil to cause the build up of FFA on storage. This is found to be especially the case with mineral acid. In destabilizing the cream emulsion at pH 8 as is done by Mattil et al. (15), the depletion of cephalin through the reaction of its orthophosphoric moiety with the base may ensue and thus result in lower stability.

In Table I the SVs of bland PM and RP oils are the same. Here the variable effect of major phospholipid on SVs approaches extinction. It has never before been interpreted that the natural odor is due to the phospholipid which is eliminated by hydration. A very interesting observation concerns the decrease of iodine value of the oil being hydrated to eliminate the major phospholipid cephalin. Bland oil is less unsaturated than the original raw oil, a fact which indicates that cephalin naturally present in coconut oil is unsaturated. This gives its distinctive chemical characteristic as subject to oxidation, which explains the exceptional stability of PM quality coconut oil (8). RP oil is next to PM oil in stability.

In the dry process of producing copra oil, there is only one by-product, which is the copra meal used only for animal feed. The coconut water has no use in the making of copra, hence it is allowed to drain into the ground. In the wet process of preparing quality water white coconut oil, the coconut water can be used for a second extraction of coconut milk. The solid residue called sapal, which remains after extraction of milk, still has the fresh coconut flavor much desired in confectionery products. It can be dried with sugar to produce sweetened coco flour for candy manufacture like coconut brittle and chocolate coated candies, or the fresh sapal can be used as a base for coconut cereals or animal feeds. The growing Brazilian coconut industry of the northeastern section of the country produces two principal products from the biggest nut: sweetened coco flour called "coco ralado" and coconut milk called "leite de coco"; the former is dried sapal of the first milk pressing with an equal amount of sugar and the latter is the coconut cream of the first pressing contained in bottles, sterilized to destroy bacteria and enzymes.

The skim milk separated from whole coconut milk contains 1% oil and 1.6% proteins, the same level of protein content as mother's milk. This is fortunate as the countries like the Philippines where the palms grow have no existing dairy industry. The skim milk can be used as a base to produce constituted coconut milk products for growing children. It can also be the base of milk for human infants like the proprietory infant milk that entered the U.S. market early in this century, based on dairy skim milk with the butter fat replaced by a synthetic fat. This product was developed to avoid the gastrointestinal ailments of human infants infected by feeding with dairy milk. Gestiera and Bahia (16) of Brazil successfully treated gastrointestinal disturbances of infants by feeding them coconut milk.

The PM high quality water white coconut oil is prepared in the same manner that butter oil is obtained from dairy butter, and a by-product of churning cooled coconut cream to produce coconut butter is the cream skim milk which corresponds to buttermilk. It contains over 3% protein. Often when this cream skim milk is added to the skim milk (1.6% protein) previously separated from whole coconut milk, the percentage of protein comes to the level of dairy market milk. In this way a coconut milk product is made which gives almost the same percentage composition as that of dairy market milk. It is the base of other milk products like evaporated milk, sweetened condensed coconut milk, and coconut milk with chocolate flavor.

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